CLAIMS

1. A process for producing naphtha and diesel from a polymer feed, the process comprising:
   (i) melting a polymer feed comprising at least 80 wt.% of polyolefin polymers to provide a molten polymer feed;
   (ii) passing the molten polymer feed to a rotary kiln reactor comprising a plurality of sequential heating zones, wherein each zone of the rotary kiln is operated at a temperature of from 300 °C to 800 °C to pyrolyze the molten polymer feed and produce a fluid product stream and a solid char product;
   (iii) separating the solid char product from the fluid product stream;
   (iv) passing a liquid fraction of the fluid product stream comprising C_{5+} hydrocarbons to a hydrogenation reactor and hydrogenating said liquid fraction to produce a hydrogenated hydrocarbon product stream;
   (v) fractionating the hydrogenated hydrocarbon product stream to produce a light hydrogenated fraction comprising C_{5-20} hydrocarbons;
   (vi) hydrocracking the light hydrogenated fraction to produce a light hydrocarbon product stream enriched in C_{5-10} hydrocarbons; and
   (vii) fractionating the light hydrocarbon product stream from (vi) to produce a naphtha fraction and a diesel fraction.

2. A process according to Claim 1, wherein fractionating the hydrogenated hydrocarbon product stream comprises fractionating in a fractional distillation column.

3. A process according to Claim 1 or Claim 2, wherein the rotary kiln comprises four or more sequential heating zones.

4. A process according to any one of the preceding claims, wherein the rotary kiln is maintained under an atmosphere of nitrogen; and/or
   wherein the rotary kiln is operated at approximately atmospheric pressure or at a slight negative pressure of 0.9 bar absolute or higher, for example 0.95 bar absolute or higher; and/or
   wherein each zone of the rotary kiln is operated at a temperature of from 310 °C to 720 °C, preferably from 400 °C to 650 °C; and/or
   wherein the final zone of the plurality of zones is heated to a higher temperature than the

other heating zones, preferably wherein the plurality of heating zones comprise sequential zones operated at from 310 °C to 600 °C in one or more zones and from 480 °C to 700 °C in a subsequent final zone.

5. A process according to any one of the preceding claims, wherein the polymer feed comprises at least 85 wt.% polyolefin polymers, preferably at least 90 wt.% polyolefin polymers, more preferably at least 95 wt.% polyolefin polymers, for example at least 99 wt.% polyolefin polymers.

6. A process according to any one of the preceding claims, wherein the polyolefin polymers comprise or consist essentially of polyethylene and polypropylene, for example wherein the polyolefin polymers comprise at least 90 wt.% polyethylene and polypropylene, preferably at least 95 wt.% polyethylene and polypropylene, for example at least 99 wt.% polyethylene and polypropylene.

7. A process according to any one of the preceding claims, wherein the polymer feed is melted in a melt extruder, preferably wherein the melt extruder is heated at a temperature of from 250 °C to 350 °C, preferably from 265 °C to 325 °C.

8. A process according to any one of the preceding claims, wherein calcium oxide is added to the polymer feed, preferably in an amount of up to 3 wt.%.

9. A process according to any one of the preceding claims, wherein at least a portion of a non-condensable gas fraction is recycled to provide heating to the rotary kiln and/or to melt the polymer feed.

10. A process according to any one of the preceding claims, wherein the solid char product comprises no more than 15 wt.% of the effluent from the kiln, preferably no more than 10 wt.%.

11. A process according to any one of the preceding claims, wherein the hydrogenation reactor in step (iv) comprises a fixed bed reactor, preferably a trickle bed reactor.

12. A process according to any one of the preceding claims, wherein the solid char product is separated from the fluid product stream at least in part by a decanter centrifuge or a tricanter centrifuge.

13. A process according to any one of the preceding claims, wherein the fluid product stream comprises a non-condensable gas fraction and a liquid fraction comprising C_{5+} hydrocarbons, wherein the non-condensable gas fraction is separated from the liquid fraction prior to step (iv).

14. A process according to any one of the preceding claims, wherein the hydrogenation catalyst is a metal catalyst, preferably wherein the metal hydrogenation catalyst comprises a metal selected from Group VIII of the periodic table, preferably the catalyst comprises Fe, Co, Ni, Ru, Rh, Pd, Os, Ir, and/or Pt, such as a catalyst comprising Ni, Co, Mo, W, Cu, Pd, Ru, Pt, and preferably wherein the catalyst is selected from CoMo, NiMo or Ni, more preferably wherein the catalyst is NiMo; and/or wherein the catalyst is supported on a carrier preferably selected from bauxite, alumina, silica, silica-alumina or zeolite, preferably alumina.

15. A process according to any one of the preceding claims, wherein the hydrocracking step comprises contacting the light hydrogenated fraction with a hydrocracking catalyst at a temperature of from 250 °C to 400 °C, preferably from 300 to 350 °C, and/or at a pressure of from 3 to 10 MPa, preferably from 4 to 8 MPa.

16. An apparatus for producing naphtha and diesel from a polymer feed, the apparatus comprising:

(i) means for melting a polymer feed comprising at least 80 wt.% of polyolefin polymers to provide a molten polymer feed;

(ii) a rotary kiln reactor configured to receive the molten polymer feed from part (i), the rotary kiln reactor configured to provide a plurality of sequential heating zones, wherein each zone of the rotary kiln is configured to be operated at a temperature of from 300 °C to 800 °C to pyrolyze the molten polymer feed and produce a fluid product stream and a solid char product;

(iii) means for separating the solid char product from the fluid product stream; and

(iv) a hydrogenation reactor configured to receive a liquid fraction of the fluid product stream comprising C_{5+} hydrocarbons from part (iii) and to hydrogenate said liquid

fraction to produce a hydrogenated hydrocarbon product stream;

(v) means for fractionating the hydrogenated hydrocarbon product stream to produce a light hydrogenated fraction comprising C_{5-20} hydrocarbons;

(vi) a hydrocracking reactor configured to catalytically crack the light hydrogenated fraction in the presence of hydrogen to produce a light hydrocarbon product stream enriched in C_{5-10} hydrocarbons; and

(vii) means for fractionating the light hydrocarbon product stream from (vi) to produce a naphtha fraction and a diesel fraction.

17. An apparatus according to Claim 16, wherein the means for fractionating the hydrogenated hydrocarbon product stream comprises a fractional distillation column configured for receiving the hydrogenated hydrocarbon product stream from the hydrogenation reactor.

18. An apparatus according to Claim 16 or Claim 17, wherein the rotary kiln is configured to provide four or more sequential heating zones, preferably wherein the rotary kiln is configured to operate as defined in Claim 4.

19. An apparatus according to any one of Claims 16 to 18, wherein the means for melting the polymer feed comprises a melt extruder, preferably configured to heat the polymer feed at a temperature of from 250 °C to 350 °C, preferably from 265 °C to 325 °C.

20. An apparatus according to any one of Claims 16 to 19, wherein the apparatus is configured to recycle a gas fraction of the hydrocarbon product stream to provide heating to the rotary kiln and/or to melt the polymer feed; and/or

wherein the hydrogenation reactor in part (iv) comprises a trickle bed reactor, preferably wherein the catalyst is as defined in Claim 14; and/or

wherein the means for separating the solid char product from the fluid product stream comprises a decanter centrifuge or a tricanter centrifuge, and/or wherein the means for separating the solid char product from the fluid product stream comprises a char outlet from the rotary kiln and a vapour outlet from the rotary kiln, separate to the char outlet, for receiving the fluid product stream the rotary kiln.